Appendix XIV.4-J

Solidification System Process Description

APPENDIX XIV.4-J SOLIDIFICATION SYSTEM PROCESS DESCRIPTION

I. Description of Treatment Equipment

The solidification system is an existing piece of equipment that is presently installed in Building 513 and will be transferred to the Building 695 Liquid Waste Processing (LWP) area. The descriptions and requirements listed in this appendix are based on the existing specifications for this equipment. The equipment is not proposed to be modified when it is moved to the LWP area. All numerical values provided in this process description are approximate and represent normal operations.

I.1 Purpose

The purpose of the solidification system is to produce solidified waste that will meet regulatory requirements for off-site land disposal and have long-term leach resistant characteristics. It is intended that uniform and thorough mixing of waste and selected solidification agents will eliminate free liquids and immobilize waste constituents thus preventing the formation of toxic leachates.

I.2 Equipment Operations

Solidification/stabilization is a commonly used industrial method for treating hazardous wastes. With this treatment process, contaminants are physically bound or enclosed within a stabilized mass and/or chemical reactions with the stabilizing agent are used to reduce the mobility of the contaminants. The binding of water into a solid matrix is generally referred to as solidification, and the immobilization of waste constituents is known as stabilization. Both processes can be accomplished by the same treatment equipment and chemical additives. To simplify the discussion in this appendix, the term “solidification” is used to refer to both solidification and stabilization treatment processes.

Figure 1 provides a process flow schematic showing for the solidification process. Wastes are solidified in 55-gal drums on a batch basis. Other types of containers approved by the U. S. Department of Transportation (DOT) may be used if required for specific waste management needs. The wastes will normally be pumped or scooped from portable tanks or containers into a 55-gal drum. A storage tank may, on occasion, be used as the source of the waste feed. Adequate freeboard is maintained for adding and mixing solidification agents.

Dry powders are the primary solidification agent used. The solidification agents include Portland cement, gypsum cement, attapulgite clay, sepulite clay, bentonite clay, montmorillonite clay, and quaternary amine silicate clay. Other solidification agents, which do not adversely impact the integrity of the solidified waste, generate gases that may result in air permit violation, or damage equipment components, may be used. ~~Although cement dusts are not hazardous, a local hood draws the dust away from workers, prevents dust dispersion, and helps to maintain the cleanliness of the solidification area. A local prefilter is provided at the hood to decrease the~~

~~maintenance requirements for the general building ventilation system (i.e., change-out of the Building 695 HEPA filters).~~ Cement dust will not be abated through a repositionable hood to a local, high-volume ventilation duct. Cement dust will be managed through housekeeping measures and, if necessary, personnel in the area will wear personal protective equipment to prevent the inhalation of cement dust.

An isometric view of the solidification system is shown as **Figure 2.** The system consists of a fixed stand to support the a double-planetary mixer, the hood that rests on the top of the drum, and the hydraulic piston that raises and lowers the hood/mixer assembly. A wheeled platform is also provided to allow one person to easily position a full drum within the mixing stand. To prevent movement during the mixing operation, the locking brakes on the wheels are engaged, and the drum is secured to the solidification system with a bracket.

Once the drum is secured, the double-planetary mixer is lowered into the drum until the hood seats against the rim of the drum. As shown on **Figure 3,** the agitators (e.g., paddles) of the double-planetary mixer turn on their own axes while rotating about each other on a central axis between the shafts. This arrangement provides thorough mixing. Other types of agitators may be used in lieu of the paddles shown in this figure. The hood/mixer assembly is supported by a hydraulic ram which allows the assembly to be lower into the drum with no physical effort from the operator. The mixer is "jogged" (intermittent and slow rotation of the agitators) to properly position and seat the hood/mixer assembly to the drum.

The hood provides a watertight, dust-tight seal that prevents liquid spillage or airborne releases into the workplace during mixing. Feed ports are provided in the hood to allow waste and solidification agents to be added to the drum after the hood/mixer assembly is lowered into place **(see Figure 2).** However, the solidification agents are normally added to the drum prior to the hood/mixer assembly being lowered.

After the batch of waste is thoroughly mixed the hood/mixer assembly is raised to allow removal of the drum from the skid platform. Any residue that remains on the agitator assembly is knocked and/or scraped off into the drum. When the treatment campaign is finished, the agitator is cleaned (washed and/or wiped) so that no visible residue remains.

Each drum is sealed with a lid to prevent spillage when it is moved to the curing area. A drum dolly is normally used to move drums. A fork lift is used when required. After curing, the waste is visually inspected to ensure that the waste and solidification agents were thoroughly mixed. The cured waste is also be tested, as required, to meet waste acceptance requirements for the off-site disposal facility. If the waste batch is acceptable, the drum is resealed and relabeled for off-site transport. Rejected waste rarely occurs and is reprocessed using additional solidification agents.

1.3 Example Solidifying Agents

Aquaset™ is a water-activated, granular solidification agent used for treatment of aqueous liquids that contain small amounts of dissolved and suspended solids, detergents, chelating agents, resins, and up to 5 percent oils. Aquaset does not require stirring, and it is simply added

to the aqueous liquid waste. Usually, solidifying 45 to 48 gal of liquid waste in a 55-gal drum requires only 100 to 150 lb of Aquaset.

Aquaset II™/ Aquaset II-H is a powdered solidification agent used either alone or in combination with Petroset™ or Petroset II™. The greatest utility of Aquaset II is in the solidification of aqueous solutions that are extremely high in dissolved solids, such as neutralized acids and bases, and those organic liquids that are water soluble or miscible. Examples of organic liquids in this category would include alcohols, benzenes, glycols, and low molecular-weight ketones. Mixtures of Aquaset II and Petroset II are ideal when these liquids are present in combination with oils and/or greases. Aquaset II requires the use of power mixing equipment.

Petroset/Petroset -H is a finely-divided powder chemically similar to granular Aquaset. Its application requires power mixing with an impeller (drum mixing). It can be used to treat wastes with high solids content, including heavy sludges. With the addition of water, dry solid wastes can be successfully treated with Petroset to meet TCLP leach-resistance standards.

Petroset II is a finely ground, strongly organophilic solidification/stabilization agent. It is used in the treatment of wastes for which some or all of the liquid components are not water-miscible (such as oils). Treatment of wastes that have both water-miscible and non-miscible components is accomplished through the use of a combination of Petroset II with Petroset, or Petroset II with Aquaset II.

I.4 Types of Waste to be Treated

The types of hazardous wastes to be managed in the solidification system are listed in the **Part A** and **Table XIV.4-2.** The target contaminant group for solidification/stabilization is generally inorganics, including radionuclides. Although this technology has limitations when treating halogenated and non-halogenated, semi-volatile organic compounds and pesticides, processes advances are being developed and tested. Solidification stabilization is relatively simple, uses readily available equipment, and has high waste processing rates compared to other technologies. At the Decontamination and Waste Treatment Facility (DWTF), the solidification process is primarily used to eliminate free liquids from waste water treatment sludges and comply with land disposal restrictions (LDRs) for off-site disposal.

II. Effectiveness of Treatment

II.1 Treatment Performance Information

One of the critical factors in producing a high-quality solidified product is complete and uniform mixing. The mixing performance of the double-planetary mixer was tested using a non-hazardous surrogate slurry consisting of clay, diatomaceous earth, and water in portions that are representative of actual waste operations. Granular particles that were of varying densities and visually distinguishable from the slurry were added to the slurry during the mixing process to verify that the mixer provides thorough and uniform mixing. The cross-sections of samples from various locations in the drum were visually inspected. These visual observations confirm that the double-planetary mixer is capable of uniformly distributing the particles throughout the slurry.

The other critical factor in the solidification process is to ensure that the additives are mixed in proper portions. Waste-specific solidification recipes have been and will continue to be developed to provide a reasonable level of confidence that the solidified waste will satisfies the following criteria:

- Elimination of free liquids as determined by the paint filter test (EPA SW-846 Method 9095)

- Immobilization of toxic RCRA and California hazardous waste constituents to comply with LDRs.

The combination and amount of the specific agents added are based on the recipes developed from processing similar waste streams and/or waste-specific treatability studies. Post-solidification analyses are used to verify that a particular waste stream was effectively treated to meet the above regulatory performance requirements. At least 10 percent of the solidified drums are analyzed, as applicable, in accordance with the Toxicity Characteristic Leachate Procedure (TCLP) and/or the California Soluble Threshold Limit Concentration (STLC) to verify compliance with the LDRs.

II.2 Process Controls

The solidification system has instruments, a programmable logic controller (PLC), and a control panel to monitor and/or adjust the items listed below. The solidification system will normally be manually operated as follows:

- Electric current, torque, and rotational speed of the mixer motor

- A timer for tracking mixing duration

- A pressure gauge for the hydraulic fluid

- An up/down toggle switch to raise/lower the hood/mixer assembly and a start/stop button for the mixer motor.

A trained operator is present whenever the equipment is being used. The operator shuts down the equipment in a safe manner if the electric current, torque, rotational speed, mixing duration, or hydraulic pressure are not within the established operating ranges.

II.3 Inspections and Maintenance

Operators are properly trained prior to being allowed to operate the solidification system unsupervised. A pre-operational safety inspection is conducted each day that the solidification system is to be used. At a minimum, the following items are visually inspected:

- Wear and damage of moving parts, especially the agitator mechanism

- General condition of the system (e.g., loose fittings or bolts, frayed wires, worn or broken seals, clear access, etc.)

- Proper function of instruments, alarms, interlocks, and emergency shut-off controls.

III. Equipment Specifications

The manufacturer of the solidification system is Charles Ross & Sons Company. The solidification system is fastened to a movable skid platform that is approximately 4 ft by 6 ft. A photograph of the solidification system is included as **Exhibit 1.** All hardware and local controls are located on the skid. Electric power, process water, and instrument air are supplied to the solidification system from the Building 695 utility systems. The skid anchoring and other structural supports are seismically designed.

The design specifications for the solidification system are listed below. Although these specifications are provided to be representative of the equipment to be transferred to Building 695, deviations may be required to match off-the-shelf items and replacement components. Most of deviations will not be significant. For any change in these specifications that could effect how the LWP miscellaneous unit treatment area is operated to maintain compliance with regulatory requirements, a permit modification is submitted to the Department of Toxic Substances Control (DTSC) for approval prior to implementing the change.

The double-planetary mixer is powered by a viable-speed, 15-hp motor. The rotational speed of the agitators can be varied from approximately 12 to 40 rpm. A separate 3-hp motor operates the hydraulic systems. All moving/rotating machine parts have guarding installed to protect against personal injury. The agitators are made of 316 stainless steel. The agitators are open paddles and rotate with an average clearance of not more than 1/4 in. (this excludes rolling hoops) between the drum wall and each other. The agitators provide for uniform mixing at the inner edge of the drum. The paddle surfaces are smooth and have a simple shape to prevent snagging.

In addition, the agitator shafts and gear box are contained within the dust hood to prevent uncontrolled airborne emissions during mixing. The height of the dust hood ranges from about 7.3 ft above the platform when resting on the rim of a 55-gal drum to about 10.3 ft when the hydraulic ram is completely extended. All metal components on the dust hood are manufactured of 300 series stainless steel. The hood has a chemically resistant neoprene gasket to provide an air-tight seal (at standard ambient conditions) when seated on a 55-gal drum. The dust hood is also equipped with an illuminated viewing window to allow visual observation of the mixing operations. The window is shatter-proof, conforming to Title 29 of the Code of Federal Regulations (CFR) Part 1910, Subpart O requirements, to protect operators against personal injury.

IV. Equipment Drawings

Drawing D3432 (Sheets 1 and 2) are included for information only to provide reviewers a more detailed visual depiction of the solidification system. The actual equipment installed within the Building 695 Liquid Waste Processing S/TUG may deviate from the dimensions, capacities, notes, and other information presented on these drawings. These deviations do not compromise the performance controls established for the solidification system or cause the LWP miscellaneous unit treatment area to violate regulatory requirements.

Figure 1. Process Flow Schematic of the Solidification System

Figure 2. Cross-sectional View of the Solidification System Skid

Figure 3. Schematic Detail of the Agitator Mechanism

Exhibit 1. Photograph of the Solidification Skid

Solidification Skid Drawings.

Click on the title to see the drawing

Main Assembly: 55 Gal Planetary Drum Mixer – sheet 1

Main Assembly: 55 Gal Planetary Drum Mixer – sheet 2